

Glacier Routing (GLACIER) Model

1. Description of Algorithm

This operation uses a routing model developed by R. D. Moore (1993)¹ to route runoff through a glacial system. The intended use of this model is to input the rain+melt time series from Snow-17 and output a modified rain+melt time series which accounts for glacial storage. The model uses a logistic function to simulate storage early in the melt season and depletion late in the melt season. Parametric input consists of two glacial routing parameters, a minimum and maximum glacial outflow coefficient and an antecedent flow index decay parameter.

¹ Moore, R.D., 1993, Application of a Conceptual Streamflow Model in a Glaciated Drainage Basin, *Journal of Hydrology*, 150:151-168

2. Model Parameters

The Glacier Routing model uses an XML representation of model parameters where each parameter is captured within a separate XML tag. The tags are closely related to the NWSRFS definition of The Glacier Routing model defined at:

<https://vlab.ncep.noaa.gov/documents/207461/1893022/533glacier.pdf>

The table below shows the available parameter tags. The sequence of parameters in the table below or in the xml file has no any significance.

| Name | Type | Required [Yes/No] | Comment |
|----------------------|---------|-------------------|---|
| TS_ID | String | Yes | Identifier of rain+melt time series |
| TS_TYPE | String | Yes | Data type code of rain+melt time series |
| TS_OUTPUT_TIME_STEP | Integer | Yes | Data time interval of rain+melt and output time series |
| TS_OUTPUT_ID | Integer | Yes | Identifier of glacier output time series |
| TS_OUTPUT_TYPE | String | Yes | Data type code of glacier output time series |
| ANTECEDENT_FLOW_ID | String | Yes | Identifier of Antecedent Flow Index Function output time series |
| ANTECEDENT_FLOW_TYPE | String | Yes | Data type code of Antecedent Flow Index Function time series |
| CG1_PARAMETER | Double | Yes | CG1 parameter |
| CG2_PARAMETER | Double | | CG2 parameter |
| AFI_DECAY_PARAMETER | Double | Yes | AFI decay parameter |
| KG1_PARAMETER | Double | Yes | KG1 parameter |
| KG2_PARAMETER | Double | | KG2 parameter |

Sample Parameter XML file is shown below:

```
<parameter id="ANTECEDENT_FLOW_ID">
    <stringValue>FAFIUG</stringValue>
</parameter>
<parameter id="TS_OUTPUT_TYPE">
    <stringValue>GOUT</stringValue>
</parameter>
<parameter id="AFI_DECAY_PARAMETER">
    <dblValue>0.9</dblValue>
</parameter>
<parameter id="TS_TYPE">
    <stringValue>RAIM</stringValue>
</parameter>
<parameter id="CG1_PARAMETER">
    <dblValue>-11.0</dblValue>
</parameter>
<parameter id="GLACIER_STORAGE">
    <dblValue>1000.0</dblValue>
</parameter>
<parameter id="INITIAL_AFI_DECAY_PARAMETER">
    <dblValue>10.0</dblValue>
</parameter>
<parameter id="TS_ID">
    <stringValue>MNDA2UG</stringValue>
</parameter>
<parameter id="CG2_PARAMETER">
    <dblValue>0.02</dblValue>
</parameter>
<parameter id="KG1_PARAMETER">
    <dblValue>0.02</dblValue>
</parameter>
<parameter id="TS_OUTPUT_ID">
    <stringValue>MNDA2UG</stringValue>
</parameter>
<parameter id="TS_OUTPUT_TIME_STEP">
    <intValue>6</intValue>
</parameter>
<parameter id="KG2_PARAMETER">
    <dblValue>0.15</dblValue>
</parameter>
<parameter id="ANTECEDENT_FLOW_TYPE">
    <stringValue>RAIM</stringValue>
</parameter>
```

3. Model States

Glacier model states are defined in a property file format. An example is shown below. The model state property names are:

| Property Name | Description |
|-----------------------------|---|
| GLACIER_STORAGE | Initial Glacier Storage |
| INITIAL_AFI_DECAY_PARAMETER | Initial Antecedent Flow Index |
| UNIT | MM - Units for State Variables (always METRIC) |

An example is shown below.

```
UNIT=METRIC
GLACIER_STORAGE =38.9
INITIAL_AFI_DECAY_PARAMETER =50.7
```

4. Model Time Series

Glacier time series: Input and output time-series have the same time interval

| Time Series Type | Internal Model Units | Time Step | Input or Output | Missing Values Allowed | Required [Yes or No] |
|-----------------------|----------------------|-----------|-----------------|------------------------|----------------------|
| Rain + Melt (RAIM) | MM | any | Input | No | Yes |
| Glacier Output (GOUT) | MM | any | Output | No | Yes |
| AFAI Output (AFAI) | MM | any | Output | No | No |

5. Notes about configuring Model in FEWS workflow

Examples:

Module Configuration File

[ModuleConfigFiles\GLACIER_BRDA2_BRDA2GL_Forecast.xml](#)

Module Parameter File

[ModuleParFiles\GLACIER_BRDA2_BRDA2GL_UpdateStates.xml](#)

6. FEWS Adapter Used

The Glacier Routing model uses the OHDFewsadapter to communicate.

Information about this adapter can be found at [OHDFewsadapter](#).